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ABSTRACT

This brochure contains an activity for grades 8-12 students that focuses on the reuse of waste as an energy source by burning and converting it into energy. For this experiment students construct a calorimeter from simple recyclable material. The calorimeter is used to measure the amount of energy stored in paper and yard waste that could be used to generate electricity. Student and teacher instructions are included. (LZ)

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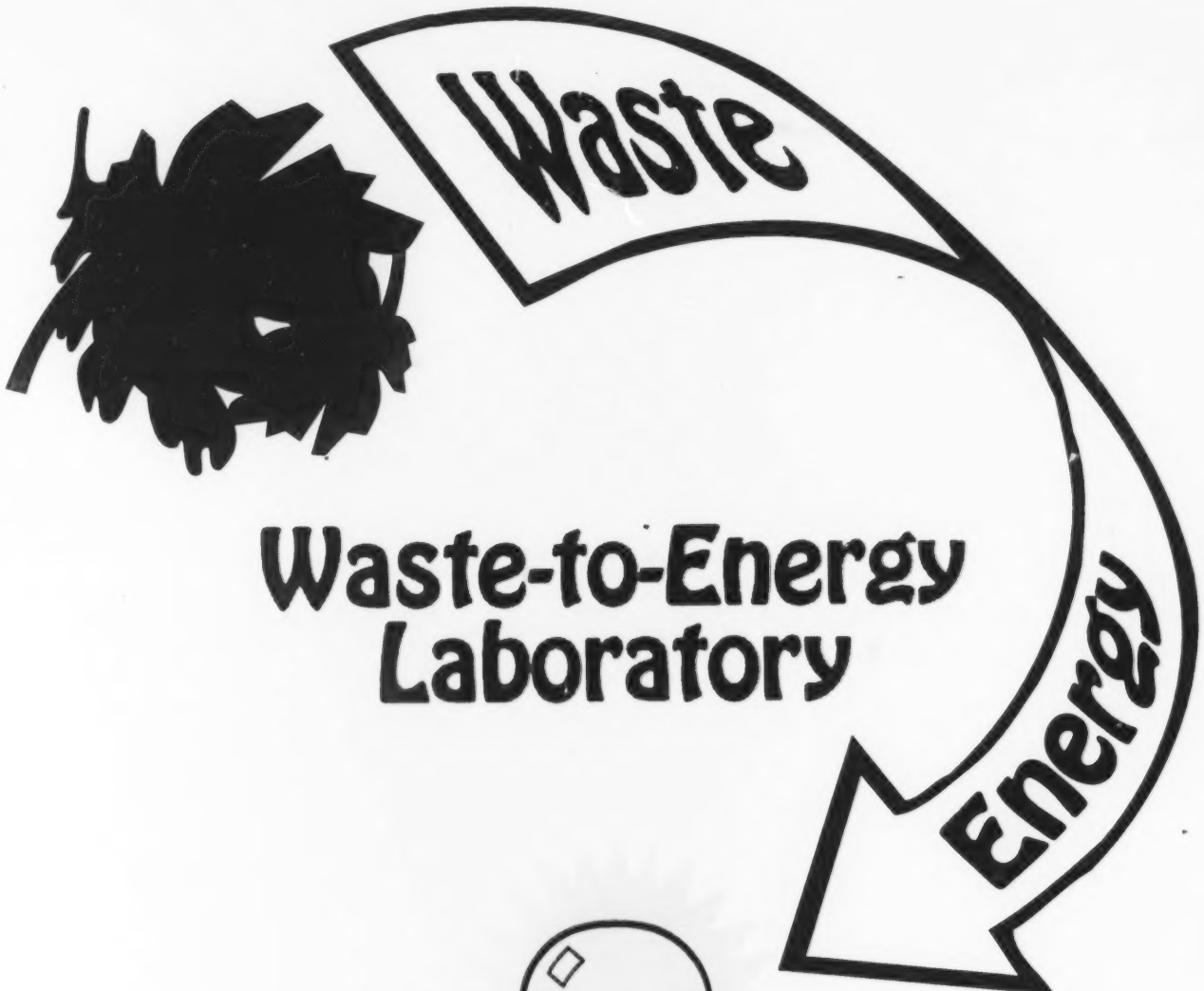

Waste-to-Energy Laboratory

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Grades 8-12

October 1994

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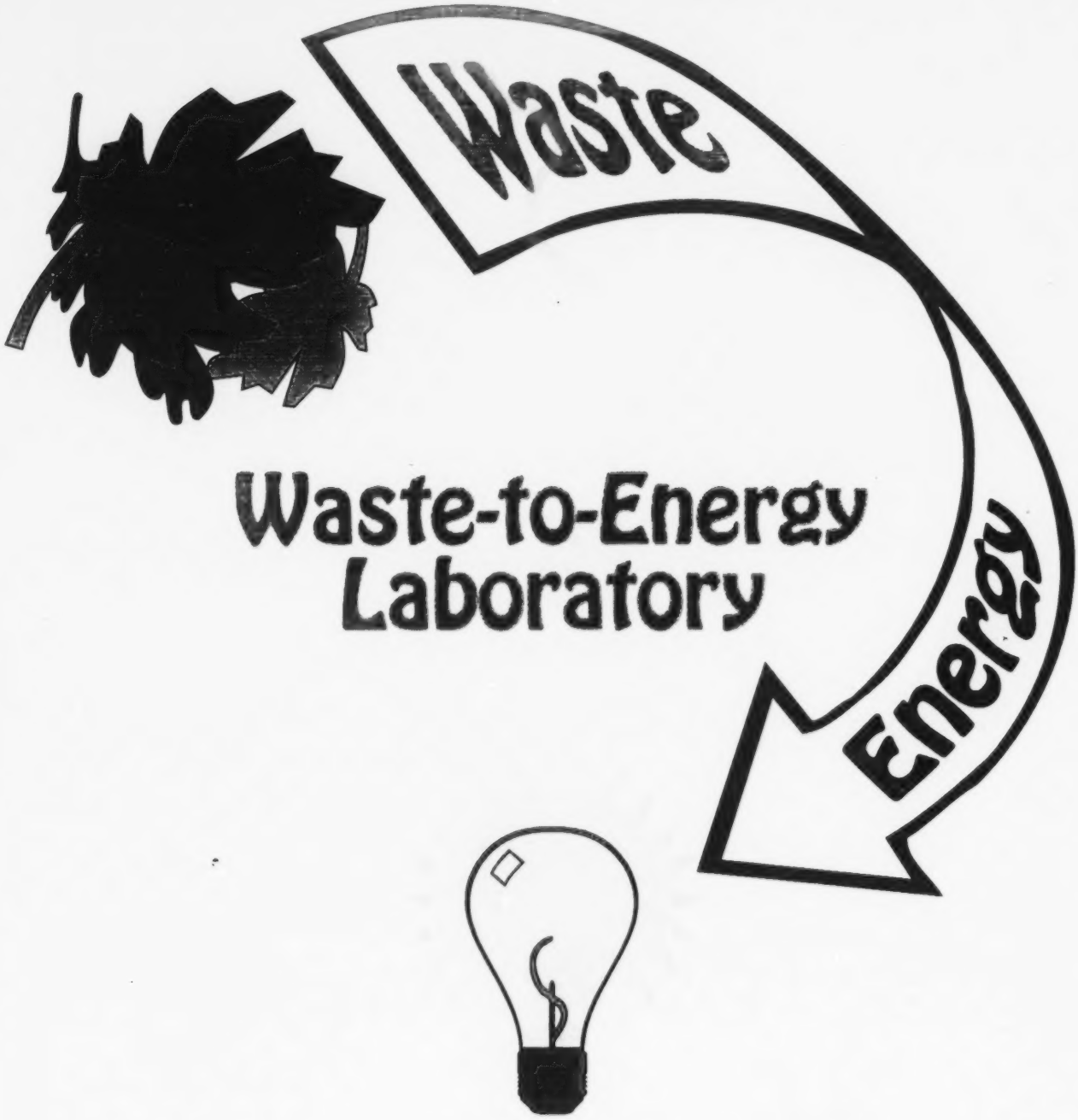

Waste-to-Energy Laboratory

Grades 8-12

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Waste-to-Energy Lab

Background:

Much of the material that is put into landfills is still useable. Many materials, such as glass, metals, paper, and plastics can be recycled. Another option is to reuse the waste as an energy source by burning some types of waste and converting it into energy (usually electric). In 1984, municipal solid waste landfills were composed of 37% paper and paper products and 18% yard waste. Both of these materials can be easily burned to create energy.

Objective:

In this experiment you will construct a calorimeter, which is used to measure amount of heat energy produced. You will also measure the amount of energy stored in paper and yard waste that could be used to generate electricity.

Materials:

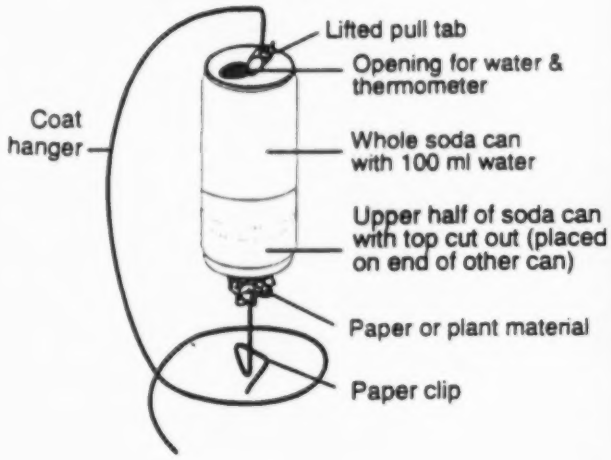
1 paper clip (large)	1 coat hanger (metal)
2 soda cans (12 oz.)	scissors
military type can opener	water
1 thermometer	burnable material (paper or dry leaves)

Procedure

Calorimeter construction:

1. Using the military can opener cut off the top of one of the soda cans.
2. Using the scissors, cut off the bottom of the can without a top, and then cut back on the can until about the middle of the can.
3. Slide the large cut end of the can over on top of the bottom of the uncut can (about 1/2 inch).
4. Bend the tab of the uncut can so that it points up.
5. Bend and shape the coat hanger so that it will suspend the two cans about two inches above a table.
6. Bend the paperclip so that it can hold the combustible material just inside the bottom of the two-can combination.

Calorimeter Setup


Lifted pull tab
Opening for water & thermometer
Coat hanger
Whole soda can with 100 ml water
Upper half of soda can with top cut out (placed on end of other can)
Paper or plant material
Paper clip

Experiment:

Because this experiment involves fire, proper precautions should be taken.

1. Pour 50 milliliter of water into the top can.
2. Crumple a piece of paper about 2" x 2". (or a dry leaf)
3. Weigh the paper (or the leaf) and record the mass.
4. Measure the temperature of the water in the can and record it.
5. Stick the paper (or leaf) onto the top of the bent paper clip.
6. Place the paperclip with material just under the can combination.
7. Light the paper (or leaf) with a match.
8. Watch the temperature, when the temperature stops rising record the highest temperature.
9. While the materials are cooling do the calculations.
10. Clean up your area.

CALCULATIONS

In accordance with the scientific laws called *thermodynamics*, we can say that the energy lost by the burning material is about the same as the energy gained by the water. Do each of the calculations and then record the results in the data table.

1. Calculate the change in temperature of the water by subtracting the initial water temperature from the final temperature $(T_f - T_i)$.

2. Calculate the amount of heat in calories gained by the water using the formula:
   heat gained = change in temperature x mass of water x specific heat of water

3. Calculate the amount of heat in joules (J) gained by the water using the formula:
   heat (joules) = heat (calories) x 4.18

4. Calculate the heat energy lost (in calories and joules) by the burned mass from:
   heat gained by water = heat lost by burned mass

5. Calculate the amount of energy that could be gotten from one kilogram (2.2 pounds) of burnable mass. Perform this calculation by dividing the amount of joules produced by the mass of the burned object, then multiplying by 1000.

6. A 50 watt light bulb means that the bulb is using 50 joules of energy every second. Calculate how long that you could run a 50 watt bulb by burning one kilogram of burnable mass. Perform this calculation by using the formula:

$$\text{time (seconds)} = \frac{\text{energy produced by burning 1 Kg mass (joules)}}{50}$$

DATA TABLE

Volume of water (mL)	
Mass of water (g)	
Specific heat of water (cal/g°C)	
Initial temperature $[T_i]$ of water (°C)	
Mass of material to be burned (g)	
Final temperature $[T_f]$ of water (°C)	
Change in water temperature $[T_f - T_i]$ (°C)	
Heat gained by water (cal)	
Heat gained by water (J)	
Heat lost by burning mass (cal)	
Heat lost by burning mass (J)	
Amount of heat energy in 1 kg of burnable mass (J)	
Amount of time 1 kg of mass could light a 50 watt bulb	

Waste-To-Energy Lab
Teacher Information

Grade Level Information:
This lab should be appropriate for science classes in the upper middle or high school range. Topics this lab could be used with: recycling; heat energy; biomass; waste to energy.

Objective
In this experiment students will construct and use a simple calorimeter using simple recyclable material (actually called reusing).

Cautions:
Some hazards to be aware of in this lab include: sharp cutting edges, matches, burning materials, hot water.

Additional Resources:

U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, Tennessee 37831
(615) 576-1301

Ask for materials dealing with energy education. Some from OSTI that may be helpful:
Science Activities in Energy: Biomass I & II (DOE/ER-516)
Science Activities in Energy: Conservation I & II (DOE/ER-519)
Science Activities in Energy: Chemical Energy (DOE/ER-518)
Energy Documents Available from the Office of Scientific and Technical Information (DOE/TIF--0082)

Integrated Waste Services Association
Two Lafayette Center
1133 21st Street, N.W., Suite 205
(202) 467-6240

Ask for *WasteWorld*, a middle school curriculum guide.

Keep America Beautiful, Inc.
9 West Broad Street
Stamford, CT 06902
(203) 323-8987

Ask for *Waste: A Hidden Resource*, a curriculum for grades 7 through 12.